INVENTIONS & INNOVATION

Success Story

ELECTRO-OPTIC INSPECTION OF HEAT EXCHANGERS

Quantitative Nondestructive Examination Technology for Tubes Provides Rapid and Accurate Measurements

Benefits

- Increases product yield by reducing unscheduled equipment downtime by detecting imperfections, corrosion, or chemical/scale buildup in heat-exchanger tubing
- Provides a faster and more reliable tubing inspection method, compared with eddy current and ultrasonics

Applications

Used to solve difficult nondestructive examination problems. Quality control tool to provide rapid and accurate measurements. Inspecting tubular material for internal corrosion/erosion, swelling and denting, and scale build-up.

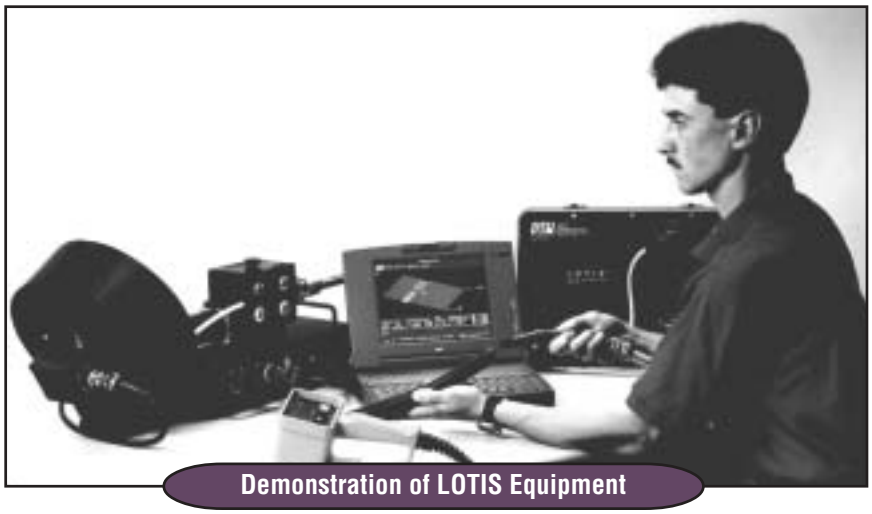
Capabilities

- Can easily visualize flaws in heat exchangers
- Allows operators to view inspection data in real time
- Fits into just two industrial-grade carrying cases and can be easily set up to begin testing in less than 30 minutes

With a grant from the U.S. Department of Energy's Inventions and Innovation Program, QUEST Integrated, Inc., developed and commercialized the Laser-Based Electro-Optic Tube Inspection System (LOTIS™). Using sophisticated laser technology, the new system offers a detailed and quantitative map of the inside surface topology of tubing in a wide variety of applications. This advanced digital signal-processing system allows operators to view data in real time. LOTIS Systems are currently being used by personnel in the QUEST Field Services Division, the U.S. Navy, and utilities around the world.

Technology Description

LOTIS works through the principle of optical triangulation, making use of nearly microscopic fiber optics to perform like a high-resolution "laser caliper." Twelve intrinsically safe laser sources in an array are sequentially pulsed as the probe is drawn through the tube, generating a quantitative map of the inside surface of straight tubing. For larger tubes, a rotating laser head is used to collect hundreds of radius measurements per probe rotation as the probe is drawn through straight or bent tubing. The results of the inspection are displayed in both tabular and graphical form for detailed analysis. The system shows scale buildup in the tubes and dents as well as other flaws, allowing preventative measures to be taken before tube failure occurs.



Demonstration of LOTIS Equipment

The optic-laser system operates as follows: (1) the optic system projects a solid-state laser beam on the inside surface of the tube, (2) the light scattered from the surface is then collected by an optic sensor, and finally (3) the optic sensor relays this data for analysis to the inspection system, which in turn provides accurate real-time information to the operator about the conditions of the internal surface.

System Economics and Market Potential

The use of laser-based electro-optic inspection technology has rapidly evolved over the last 15 years. By using miniature optics, high-speed digital processing electronics, and computer graphic data presentation software, laser-based tube inspection systems have been developed for a broad spectrum of testing and quality assurance/quality control applications. QUEST's proprietary laser-based electro-optic testing equipment is currently being applied globally to inspect tubing with inner diameters ranging from 0.44" to 5.5." In particular, boiler tubing has been one of the most successful environments for this technology, and its measurement accuracy has long been established and proven with destructive analysis.

QUEST's user-friendly software allows data to be presented and analyzed in various simple formats, which include contour, cross-sectional, and isometric views. The cross-sectional view allows the operator to view the internal tube damage (i.e., pitting) as if the tube had been cut in both the circumferential and axial planes. In addition to being user friendly, all graphical views supply the analyst with quantitative digital information regarding the depth, width, length, and position of any pit in the tube. Furthermore, versatile reporting features provide either simple presentations to plant owners or thorough component breakdowns for the detail-oriented engineer.

According to QUEST, 13 units are currently in operation, with the strongest selling point being the ease in visualizing flaws in heat exchangers. The technology was commercialized and marketed under the trade names LOTIS-200K and LOTIS-400N, and it offers a simple three-step process to quickly provide quantitative data about the condition of a tubing.

Inventions and Innovation Program

The Inventions and Innovation Program provides financial assistance for establishing technical performance and conducting early development of innovative ideas and inventions. Ideas that have a significant energy-savings impact and future commercial market potential are chosen for financial support through a competitive solicitation process. Inventions funded by the program have saved enough energy to light 10 million homes per year. In addition, the program offers technical guidance and commercialization support to successful applicants. Ideas that benefit the Industries of the Future, designated by the Office of Industrial Technologies as the most energy-intensive industries in the United States, are especially encouraged.

"The Inventions and Innovation grant allowed QUEST Integrated scientists and engineers to develop a new NDE technology that lets you determine the exact condition of your safety-critical tubing with confidence. "

– Phil Bondurant
Vice President
QUEST Integrated, Inc.
Kent, WA

For project information, contact:

Mr. Phil Bondurant
Vice President
QUEST Integrated, Inc.
1012 Central Avenue South
Kent, WA 98032
Phone: (253) 872-9500
ext. 1356
Fax: (253) 872-8967
philb@qi2.com

Home Page:
www.qi2.com

For more information about the Inventions and Innovation Program, contact:

Lisa Barnett
Program Manager
Inventions and Innovation Program
U.S. Department of Energy
1000 Independence Avenue SW
Washington, D.C. 20585-0121
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

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